

***Capstone C-30s CHP
Project
Faith Plating,
Los Angeles CA***

***Rod Hite
Energy and Environmental
Analysis, Incorporated***



www.bumper.com



*World's Largest Plater of
Remanufactured Chrome Bumpers*

Since 1918



www.bumper.com



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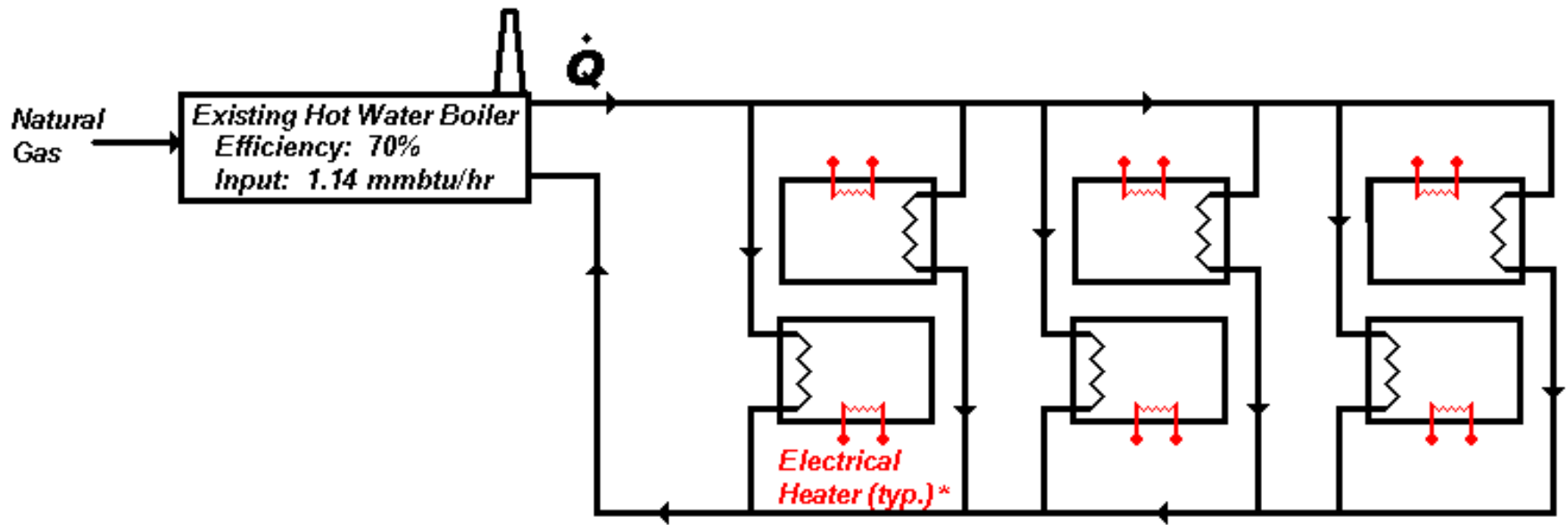
Organisation

- ***Project Manager:*** ***All Temperatures Controlled***
- ***Funding Partners***
 - ***Faith Plating***
 - ***Southern California Gas Company***
 - ***Department of Energy***
- ***Engineer:*** ***All Temperatures Controlled***

Scheduling Issues

- ***The plant was installed pretty much as expected.***
- ***The equipment was available on schedule.***
- ***Interconnection with the electric utility generated delays.***

Faith Plating's Thermal Needs



*** 113 kw Total**

Dip Tanks

Existing Boiler



Dip Tank



***Tank Heating
Coils (on the wall
behind and under
the horizontal
pipe that crosses
the tank)***





***Water Treatment
System***

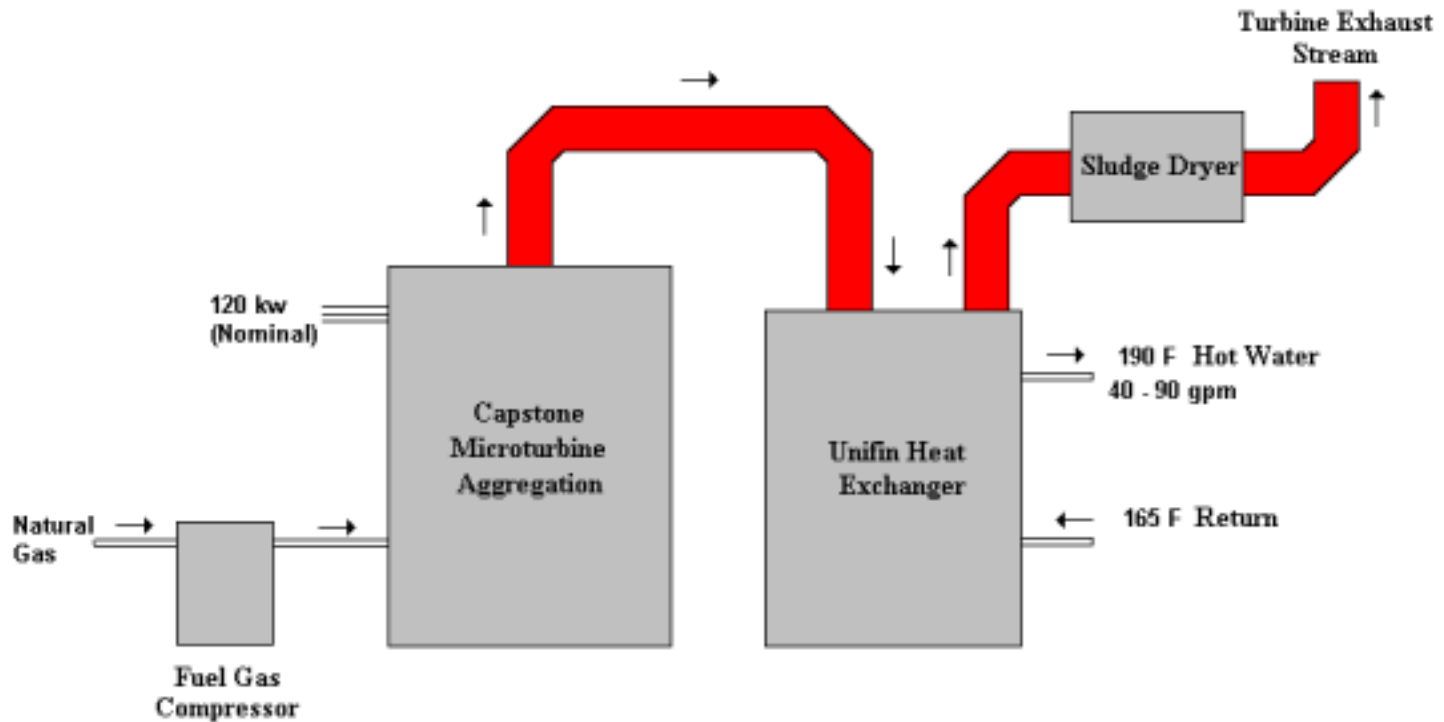


***Previous Precipitate
Dryer***

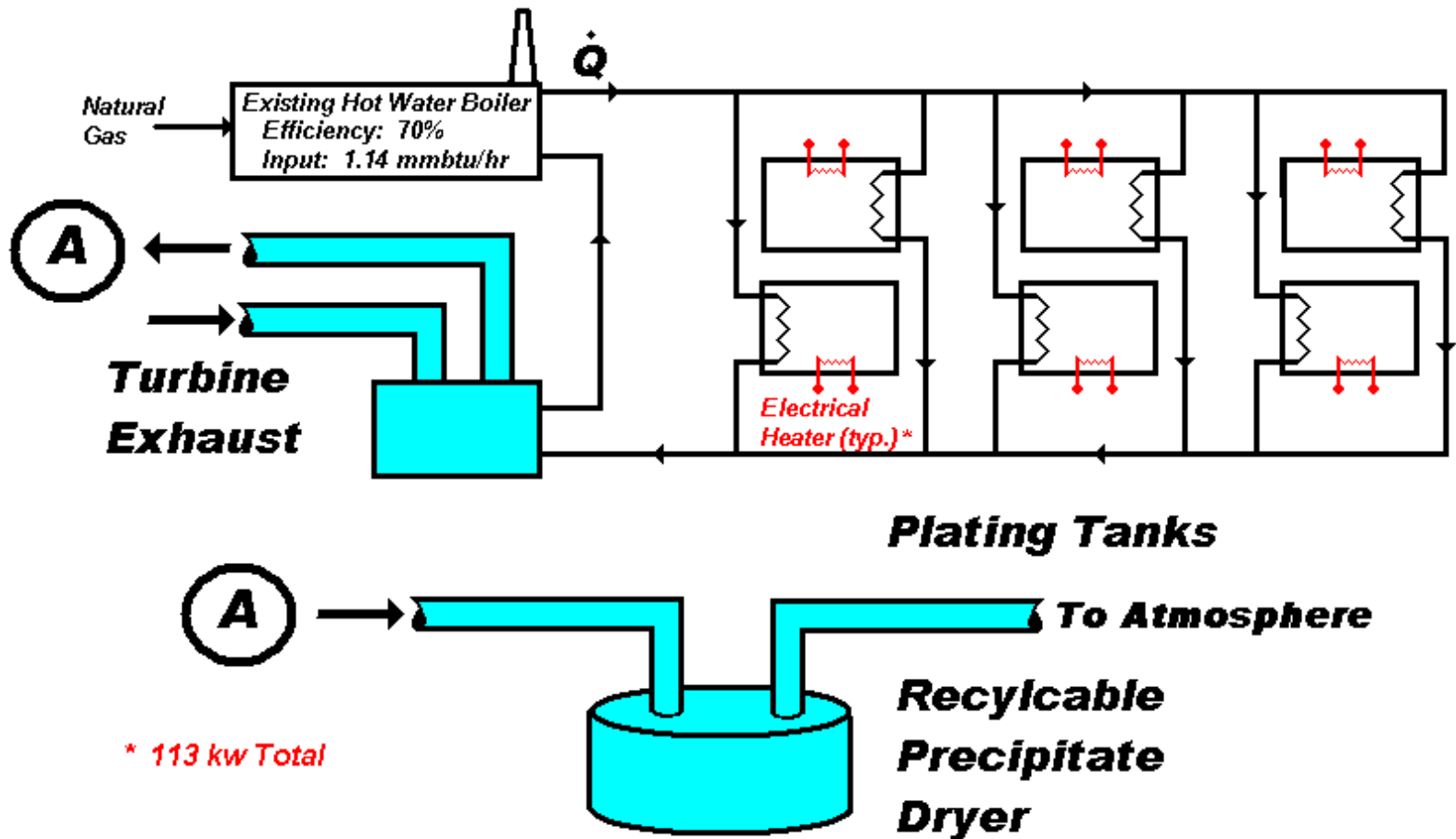


Drying Precipitate

The CHP System



The Thermal Layout





***Two of Four C-30
Capstones***



***Unifin Heat
Exchanger***

***Receives
Turbine
Exhaust***



Dryer Exhaust

A Comparison of Precipitate Drying Before and After

Precipitate to be Shipped



Before



After

Project First Cost

<i>Hot Water Coils and Plumbing</i>	<i>\$14,194</i>
<i>Area Preparation (Materials and Labor)</i>	<i>\$20,472</i>
<i>Permitting and Interconnection</i>	<i>\$800</i>
<i>Equipment and Installation</i>	<i>\$218,220</i>
	<hr/>
<i>Total:</i>	<i>\$252,561</i>

***Hours of Operation
(from August, 2001 to January 2003)***

Turbine 1 8,233 Hours

Turbine 2 6,026 Hours

Turbine 3 7,736 Hours

Turbine 4 7,907 Hours

Typical Data

So Cal Gas _ Applied Technologies

Faith Plating Co.

Time is 23:50:55.08.

Date is 11-17-2002.

Time	gas pres psig	Gas Temp 'F	Stack Te 'F	Inlet Wa 'F	Outlet Wa 'F	Ambient 'F	Ambient %	Ambient 'F	Ambient %	Water gpm	Power kw	Total Ga cf	Gas Flow scfh
0:00:55	4.9869	69.6702	354.3902	148.4532	163.6416	88.0612	18.9547	94.6368	16.1701	75.5061	63.112	162	874.6561
0:01:55	4.9812	69.6663	354.57	148.5476	163.5539	88.0026	19.0185	94.7186	16.0383	75.5028	63.1061	165	874.6803
0:02:55	4.9795	69.6951	352.324	148.6171	163.6058	88.0137	19.0551	94.7537	16.0526	75.4958	63.1013	168	874.6151
0:03:55	4.9787	69.6676	352.5367	148.6725	163.781	88.1227	18.9319	94.7762	16.0528	75.49	63.0967	171	874.5837
0:04:55	4.97	69.6483	350.5278	148.8925	163.6187	88.1014	18.9332	94.6978	15.9901	75.4836	63.0925	174	874.653
0:05:55	4.9753	69.7178	351.439	148.7615	163.8095	88.2324	18.779	94.6849	16.0886	75.4782	63.0881	177	874.6744
0:06:55	4.9836	69.6586	350.7361	148.9143	163.7622	88.1965	18.8965	94.5624	16.146	75.4724	63.0841	180	874.6246
0:07:55	4.976	69.677	351.1689	148.8723	163.8982	88.1056	18.9405	94.6926	16.0272	75.4692	63.0803	183	874.6292
0:08:55	4.9765	69.6659	349.6382	148.9878	163.9595	88.0754	18.906	94.7703	16.0413	75.4646	63.0769	185	874.6481
0:09:55	4.9696	69.6759	350.5424	148.9748	163.9908	88.1965	18.8208	94.7241	16.0335	75.4598	63.0742	188	874.6666
0:10:55	4.9785	69.6705	351.9163	148.9738	164.046	88.1858	18.8256	94.7929	16.1147	75.4545	63.0723	191	874.7488
0:11:55	4.9757	69.6525	358.8364	149.0779	163.9827	88.2562	18.7272	94.747	16.1326	75.4501	63.0699	194	874.7753
0:12:55	4.9784	69.6966	359.2984	149.2302	164.2321	88.1378	18.7273	94.729	16.1991	75.4453	63.0671	197	874.7924
0:13:55	4.9669	69.6333	356.7647	149.3047	164.1004	88.1446	18.7772	94.8068	16.2444	75.4412	63.0646	200	874.7366
0:14:55	4.9854	69.6167	352.5918	149.1641	164.2245	88.0728	19.001	94.826	16.2204	75.4367	63.0614	203	874.7154
0:15:55	4.9684	69.6529	354.0201	149.2984	164.2672	88.0991	19.0198	94.8356	16.1726	75.4312	63.0591	206	874.7648
0:16:55	4.9765	69.6374	354.6878	149.3663	164.3623	88.0692	18.9574	94.679	16.2802	75.4244	63.0565	209	874.7112
0:17:55	4.9727	69.6305	352.1481	149.4977	164.4124	88.0424	18.9376	94.6991	16.2747	75.4189	63.0543	212	874.7288
0:18:55	4.9756	69.6749	351.8123	149.5153	164.3743	87.9809	19.0198	94.6536	16.3691	75.4148	63.0514	215	874.6861
0:19:55	4.9811	69.6414	353.4019	149.4487	164.6004	87.9768	19.0396	94.6793	16.3566	75.4113	63.0485	218	874.6893
0:20:55	4.9725	69.6311	353.3828	149.4952	164.4801	88.0637	19.1481	94.6175	16.4414	75.4075	63.0457	220	874.7039
0:21:55	4.9601	69.6121	354.2648	149.513	164.6876	88.0256	19.1849	94.6053	16.3757	75.4043	63.0432	223	874.6536
0:22:55	4.9812	69.65	353.9756	149.6821	164.5953	87.9392	19.2741	94.5047	16.4944	75.4007	63.0405	226	874.6713
0:23:55	4.9859	69.652	353.6344	149.7352	164.6416	87.9809	19.1002	94.5103	16.4388	75.3977	63.0389	229	874.7333
0:24:55	4.9719	69.6219	353.2765	149.7546	164.5709	88.0846	19.055	94.4687	16.4129	75.3944	63.0374	232	874.7605
0:25:55	4.9772	69.6353	353.3583	149.748	164.6728	88.0415	19.0804	94.4063	16.4039	75.3913	63.0361	235	874.6516
0:26:55	4.9714	69.6263	352.6928	149.8616	164.8636	88.0484	19.0515	94.4175	16.4205	75.386	63.0345	238	874.6677
0:27:55	4.9657	69.6435	352.8771	149.9641	164.6932	88.12	19.0325	94.521	16.3431	75.3814	63.0332	241	874.7059

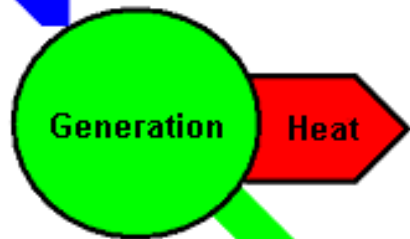
Thermal Energy Was Derived

$$\dot{Q} = \dot{m}c_p\Delta T$$

System Performance

Average Case: 1.42 mmbtu/hr, 19,884 btu/kwh (hhv, net)
Best Case: 1.77 mmbtu/hr, 18,791 btu/kwh (hhv, net)

Fuel



Electricity

Average Case: 71.7 kw
Best Case: 94.2 kw

Hot Water

Average Case: 580,000 btu/hr
Best Case: 740,000 btu/hr

Dryer Needs

Exhaust

{ Not Instrumented,
Estimated to be From
500,000 to 650,000 btu/hr

Overall Efficiency*

Average Case w/o Dryer: 58%

Average Case w/ Dryer: 90%

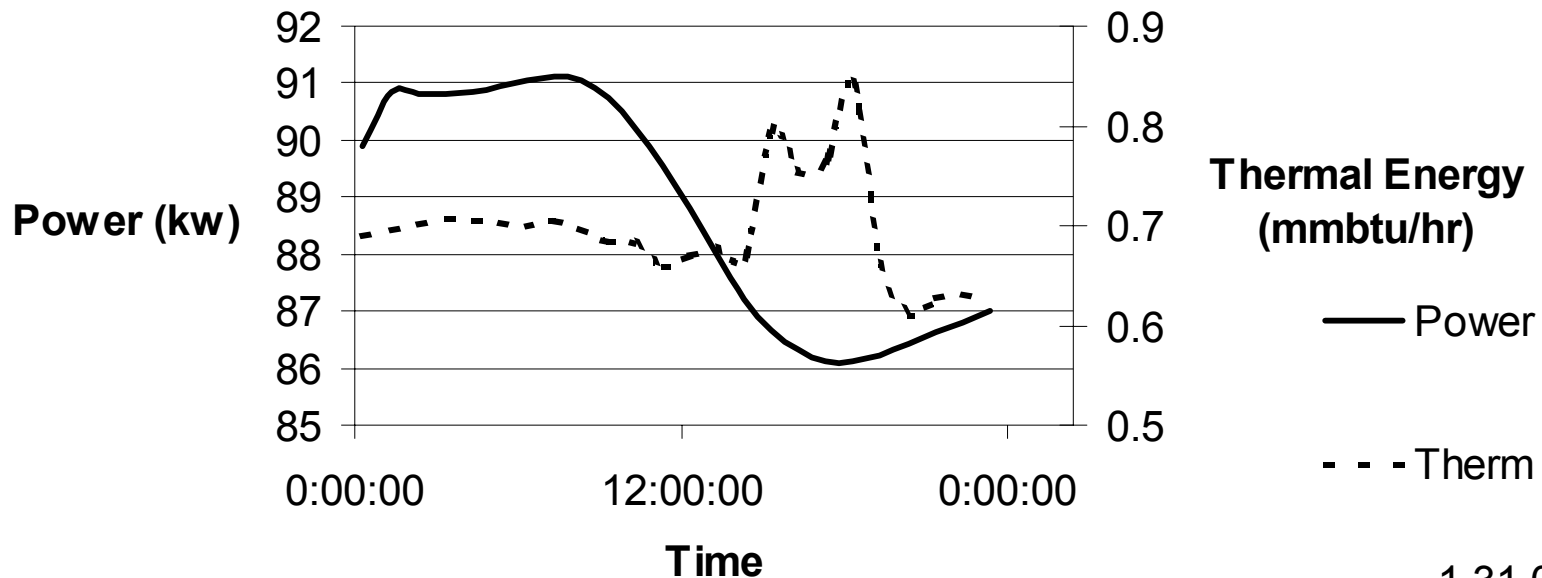
Best Case w/o Dryer: 60%

Best Case w/ Dryer: 90%

**** Daily Averages***

As a General Rule, Thermal Output was Decoupled from Power Output

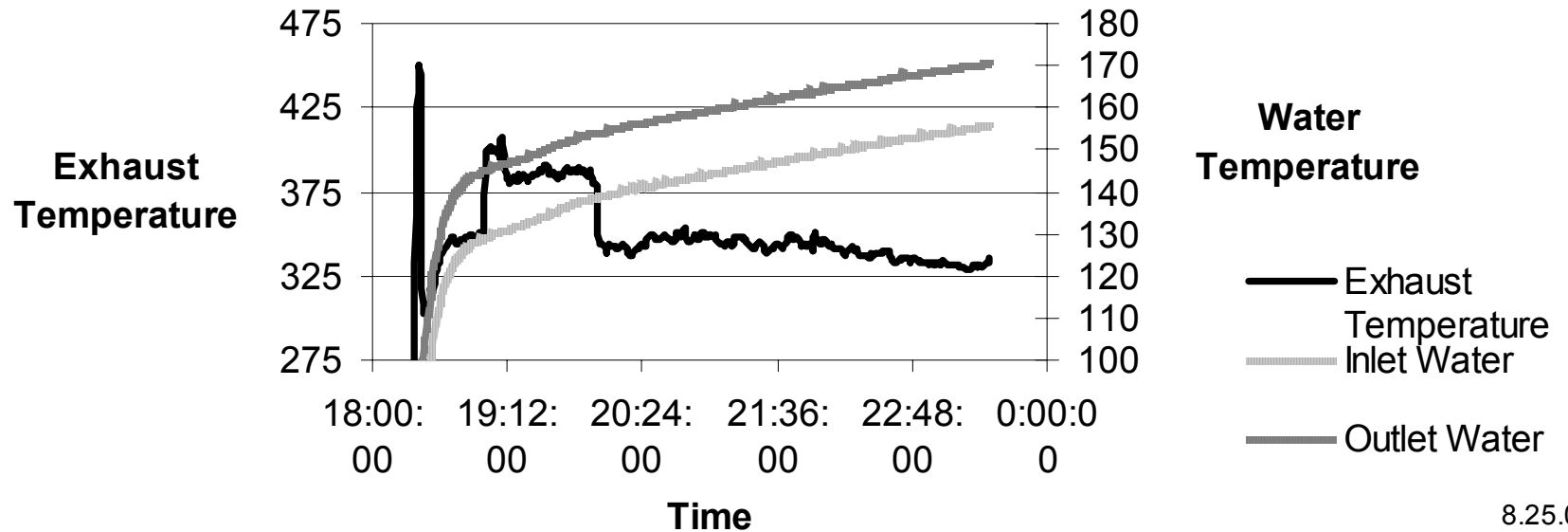
Figure 4



1.31.03

Startup on a Sunday

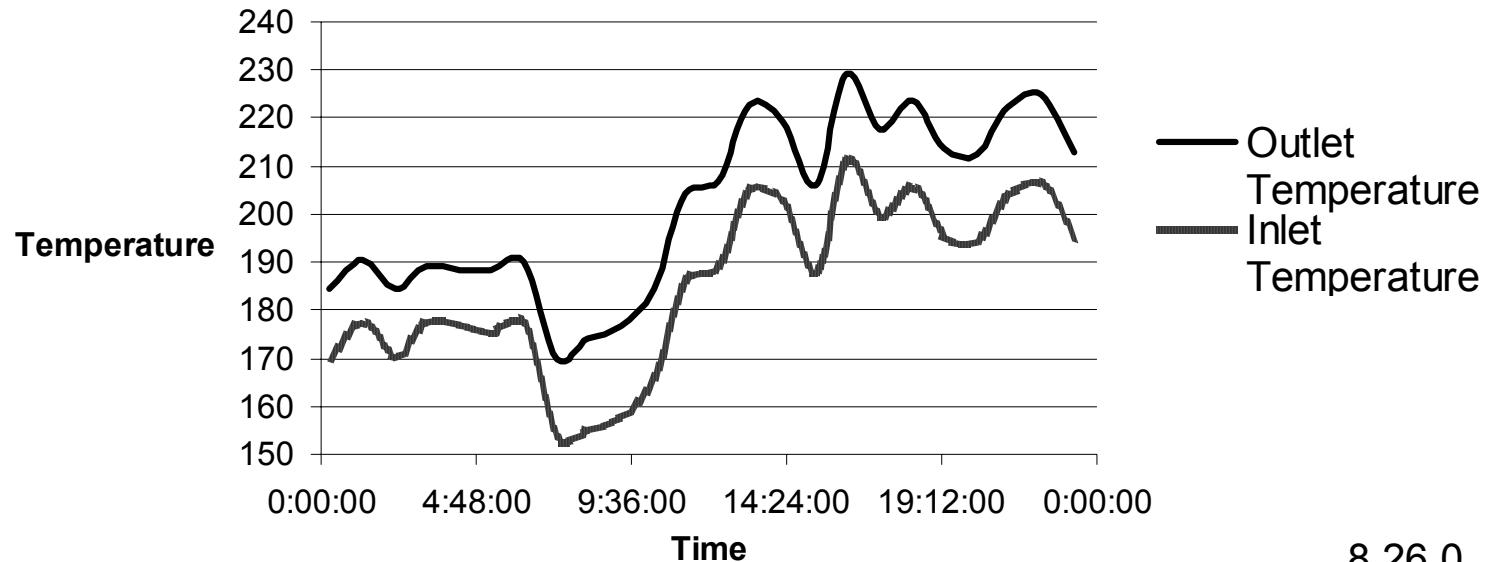
Figure 6



8.25.02

There Were Some Interesting Days

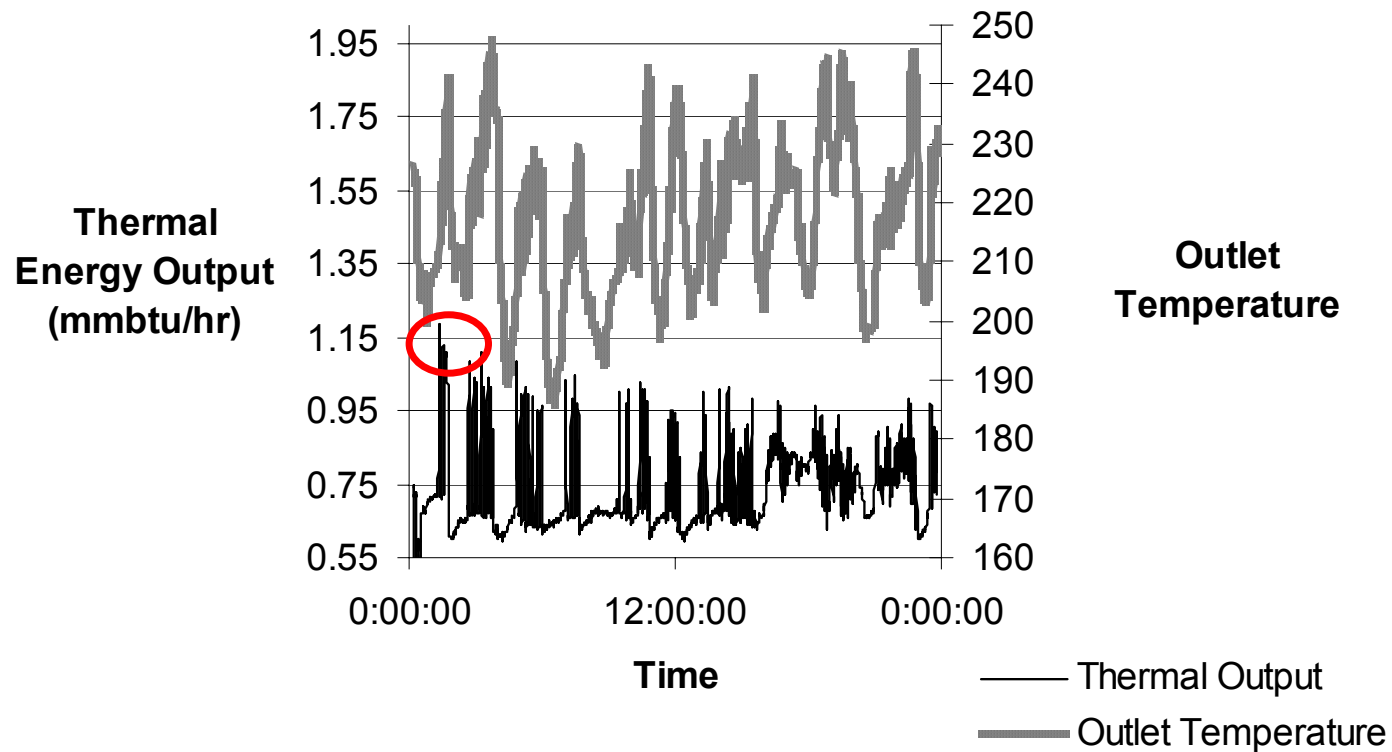
Figure 11



8.26.0

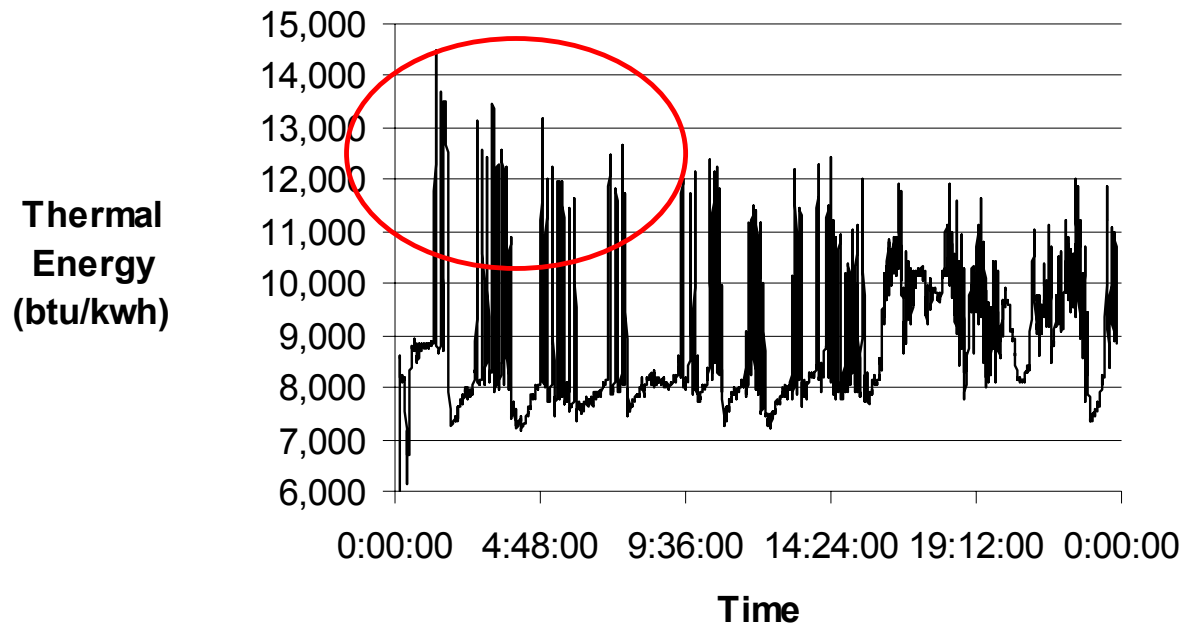
Another Day When Temperature Control Was Lost

Figure 18



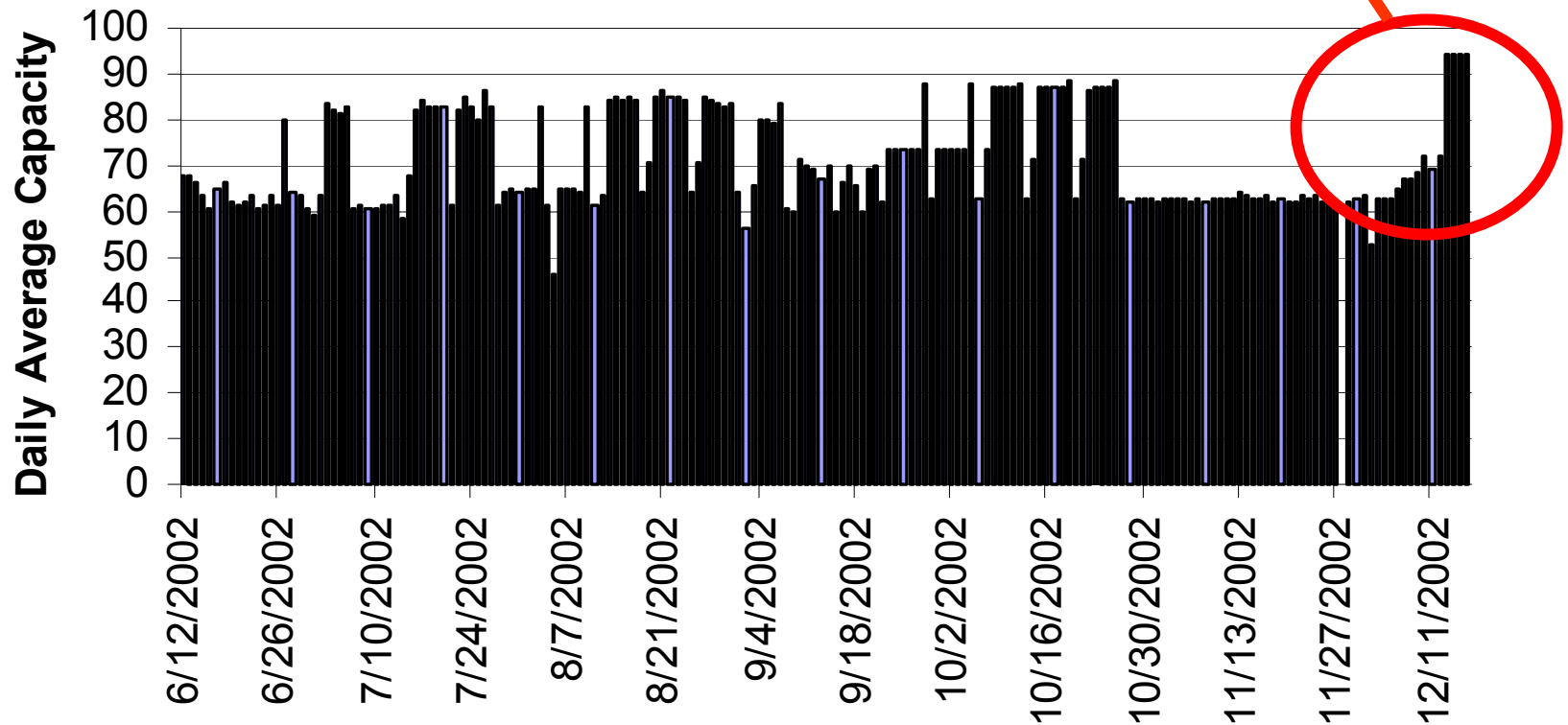
The Plant's Ability to Produce Hot Water

Figure 18



Daily Average Capacity

Indicates performance improvement resulting from a change in the demand setting.



O&M Performance

- ***Availability*: 89%***
 - ***Lost Engine Run Hours: 1000***
- ***Maintenance Costs**:***
 - ***Annualized: \$10,400***
 - ***Per kilowatt-hour: \$0.19***

**** Aug 15, 2002 to January 8, 2003***

***** April, 2002 to January, 2004***

Institutional Experience

- ***Only significant start-up issue was with Southern California Edison***
- ***An expert is needed on staff!***

Turbine Inlet Cooling Could Add 2 to 5 kw



Supplier Support

- ***Everybody seemed to be in the “ankle” part of the learning curve.***
- ***There was an issue regarding bypass dampers for the microturbines.***

Bypass Dampers Should Go Here



Supplier Support (Cont.)

- ***Intake filters were cheaper at the auto supply store.***
- ***More skill would have been useful.***
- ***Lots of disappointment with the heat exchanger.***
- ***Weeks of down time resulted from waiting on parts.***

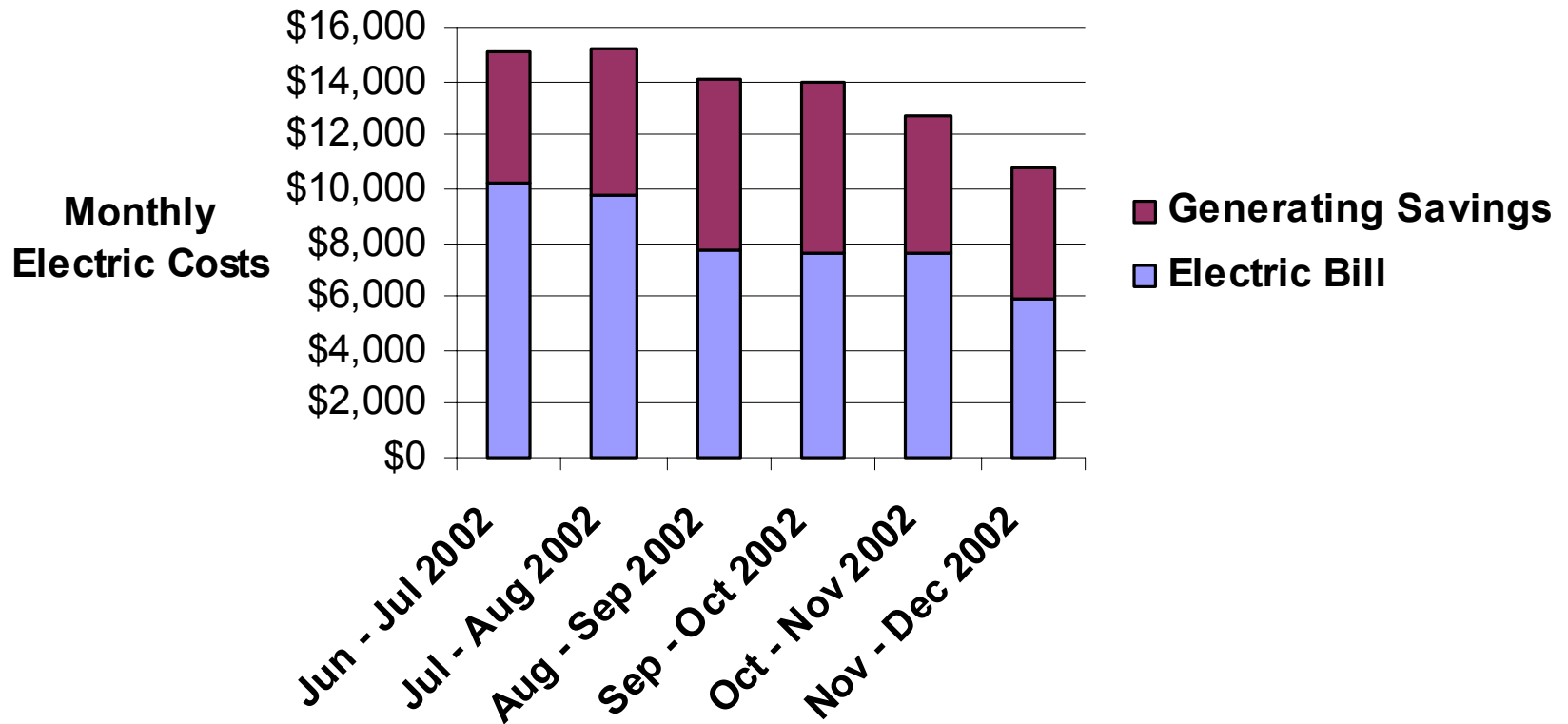
General Experience

This customer questions the industry's value proposition that microturbines are low maintenance machines.

“It’s kind of like your own car. If you work on it yourself, you know how to keep it running.”

***Mark Young,
General Manager***

Electric Cost Savings



Economics (Aug-Sep, 2002)

	<u>Just Boiler Offset</u>	<u>Electric Immersion</u>
Generation Savings:	\$6,400	\$6,400
Fuel Costs:	(\$4,341)	(\$4,341)
Boiler Fuel Savings:	\$2,496	\$796
Maintenance:	<u>(\$870)</u>	(\$870)
IH Energy Savings:		\$8,375
IH Demand Savings:		<u>\$1,486</u>
Total Savings:	\$3,685	\$11,846

Annualized Savings

***Thermal Energy Displaces
Boiler Fuel:***

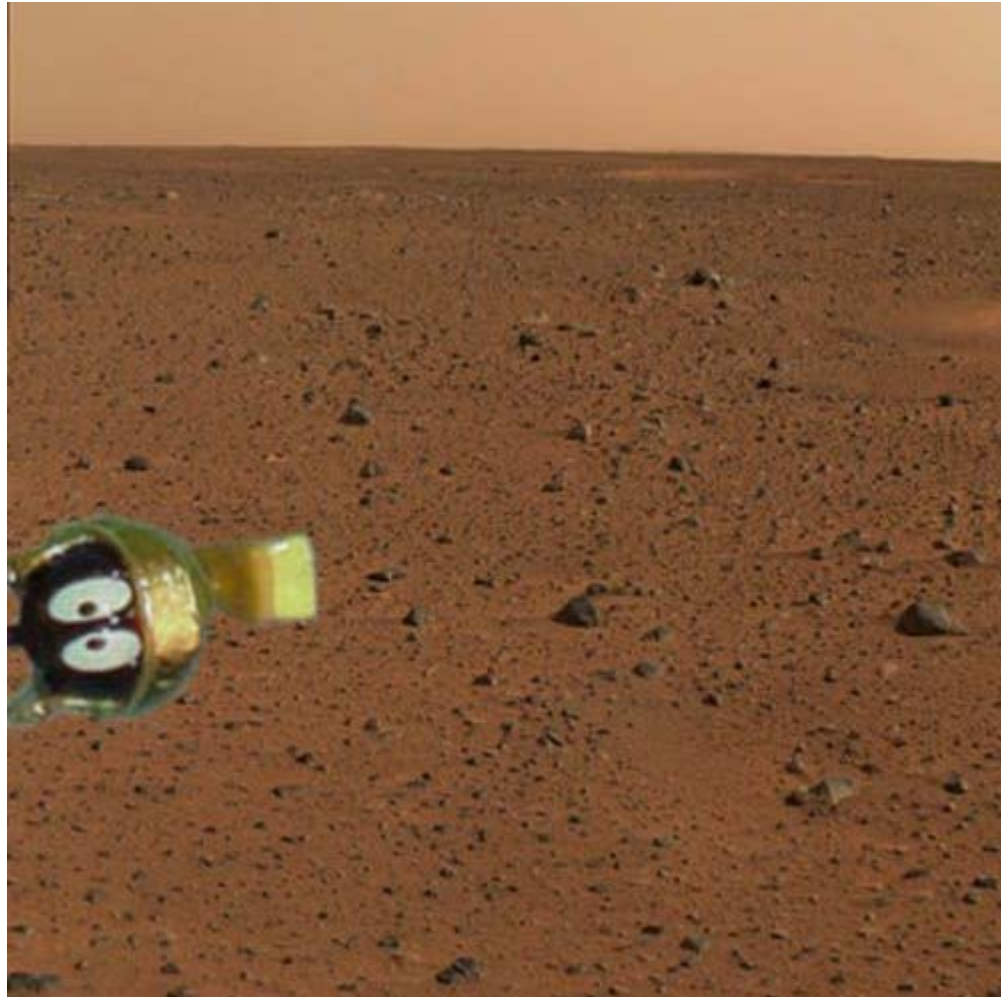
\$45,000

***Thermal Energy Displaces
Electric Heaters:***

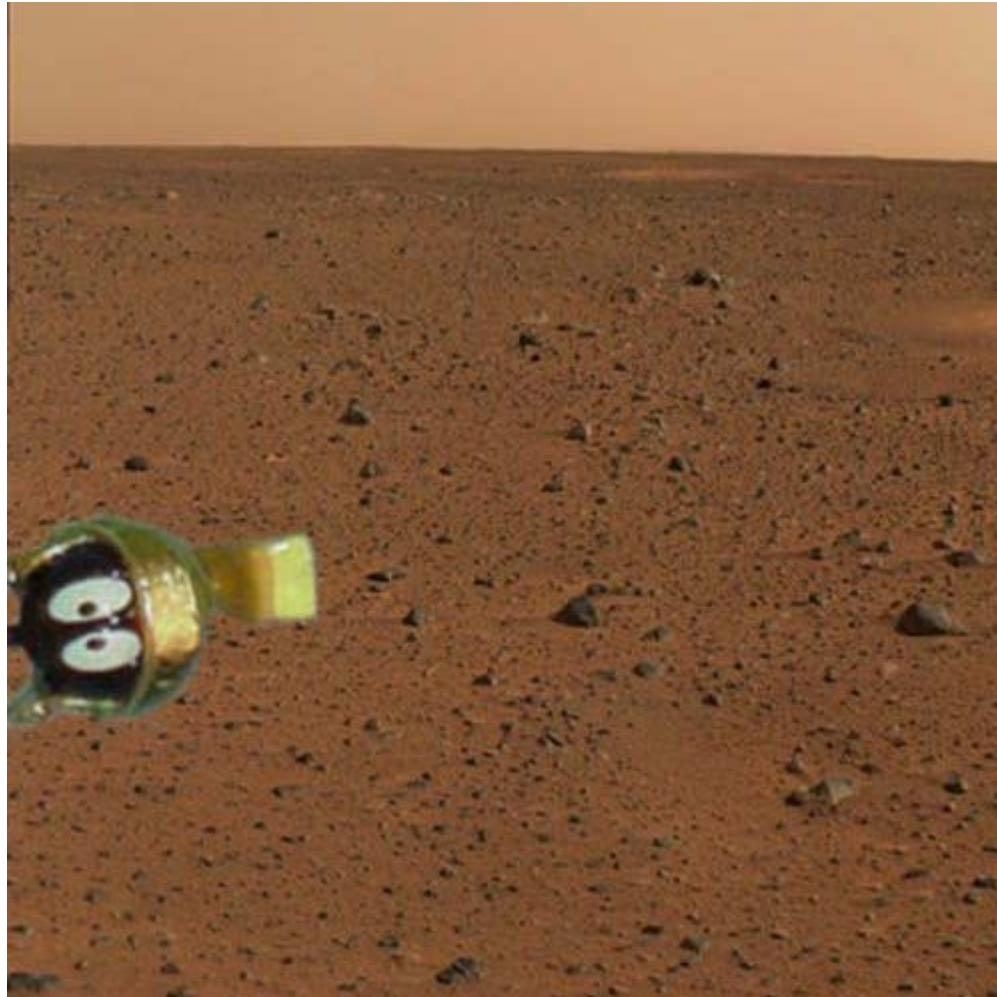
\$132,900

The Usual Suspects





Questions?



Spirit's Real First Photograph